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## WORD ORDER UNIVERSALS REFLECT COGNITIVE BIASES: EVIDENCE FROM SILENT GESTURE

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Research in linguistic typology has identified many cases in which particular patterns appear to be over- or under-represented in the world's languages. The extent to which these so-called typological universals reflect universal properties of human cognition remains heavily debated. In this paper, we provide empirical evidence connecting universals of word order to cognitive biases using a silent gesture experiment. The silent gesture paradigm allows us to capture spontaneous, untrained responses in a modality distinct from participants' previous language experience (Goldin-Meadow, So, Özyürek, & Mylander, 2008).

Our starting hypothesis comes from Greenberg's Universal 20 (Greenberg, 1963), concerning how adjective, numeral, demonstrative and noun are ordered. The distribution of possible orders of these elements is heavily skewed and it has been proposed that the common orders are those which match up transparently with the underlying semantics (Abels & Neeleman, 2012; Culbertson & Adger, 2014). The semantic relations between these elements are shown in Figure 1, and orders which are isomorphic to them can be read off directly without swapping the position of any of the modifiers. For example, N-Adj-Num-Dem and Dem-Num-N-Adj are isomorphic, Num-Dem-N-Adj and Adj-Num-Dem-N are not.



Figure 1. Schematic of semantic relations among elements in the noun phrase. Adj is conceptually closest to N, Dem most distant (Rijkhoff 2004).

Artificial language learning experiments show that English-speaking participants trained only on phrases with single post-nominal modifiers infer relative modifier orders that are isomorphic (e.g., N-Adj-Num-Dem; Culbertson & Adger, 2014). However, this study does not provide unambiguous evidence for a universal isomorphism bias, since English-speakers may have learned it from their L1 (Dem-Num-Adj-N is isomorphic). We use the silent gesture paradigm to test this bias in a modality distinct from participants' previous experience.

Stimuli consisted of simple pictures with a set (4 or 5; Num) of triangles or squares (N), all either spotted or striped (Adj). On each trial a stimulus appeared in one of two positions—proximal or distal to the participant (Dem). Participants were told to use gesture to communicate all the relevant information to another person. There is no training, therefore this is a test of naturalness of ordering.

Participants (N=20; native-English speakers, no experience with sign languages) each provided 32 gestures. Each gesture was coded and then scored according to whether it used post-nominal modifiers, and whether the relative order of the modifiers provided was isomorphic. The former measure, shown in Figure 2A, reveals that in general participants did *not* show a tendency to use English order—most dramatically, almost all gestures provided used a post-nominal adjective. This accords with a typological tendency that English violates (Greenberg, 1963). Critically, gestures also showed a very strong tendency toward isomorphic orders (Figure 2B) among all modifier pairs—whether pre- or post-nominal—supporting the hypothesis that Universal 20 reflects a cognitive bias favoring isomorphism.

This finding provides general support for a connection between statistical language universals and cognitive biases. We will discuss the extent to which our participants gestures reflect purely conceptual or linguistic factors, and the methodological implications of this for the silent gesture paradigm.

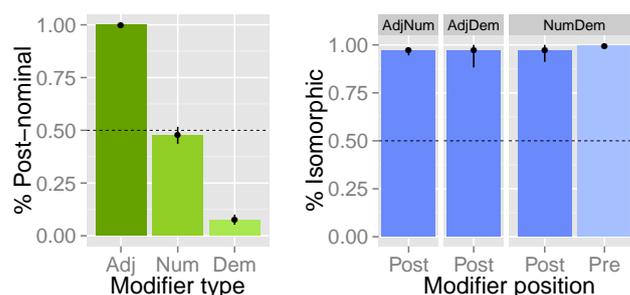


Figure 2. (A) Proportion of responses using post-nominal ordering for each modifier type. (B) Proportion of responses that are isomorphic, for each modifier pair, pre- and post-N.

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